HISTORICAL GENERATION AND FLOW OF RECYCLED URANIUM IN THE DOE COMPLEX

Project Plan

U. S. DEPARTMENT OF ENERGY

FEBRUARY 2000

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The Deputy Secretary of Energy
Washington, DC 20585

September 15, 1999

MEMORANDUM FOR ALL DEPARTMENTAL ELEMENTS

FROM: T. J. GLAUTHIER

SUBJECT: Paducah Gaseous Diffusion Plant--Follow-Up Activities

On August 8, 1999, Secretary Richardson announced a comprehensive set of actions to address the issues at the Paducah Gaseous Diffusion Plant that may have the potential to affect the health of the workers. One of these issues, which is of complex-wide significance, is the need to determine whether radioactive fission products and plutonium in the uranium feed or waste streams existed in concentrations that present a potential health or environmental concern. These fission products and transuranic contaminants are contained in *recycled uranium*, i.e., uranium that had been irradiated in a nuclear reactor, recovered through a separations process, and then sent to the gaseous diffusion plant for enrichment or to another location for use. The DOE and its predecessor agencies produced over 100,000 metric tons of this material, which was sent throughout the DOE complex.

The Department needs a clear understanding of the mass flow and characteristics of this recycled material to assess the potential for health or environmental contamination issues. Therefore, I have asked the Office of Environment, Safety and Health to coordinate a project to determine the mass flow and characteristics of DOE recycled uranium over the last 50 years, as well as a characterization of site radiological conditions and worker medical screening at Paducah, Portsmouth, and Oak Ridge's former K-25 facility. Within the constraints of historical data, the goals of this project are to:

- Identify the mass flow of DOE recycled uranium from early production to mid-1999, including ultimate use and disposition. Create an unclassified inter-site flow sheet for public availability.

- Identify the characteristics and contaminants in the major uranium streams, specifically, the technetium, neptunium, plutonium or other isotopic content of concern to worker or public health and safety.

- Conduct site *mass balance* activities sufficiently thorough to identify any significant implications for potential personnel exposure or environmental contamination.

- Conduct an occupational radiation exposure profile project at the three indicated sites to characterize radiological conditions and the boundaries of occupational radiation exposures.

I am requesting that the site Lead Program Secretarial Officers, other Program Secretarial Officers, and corresponding field and operations offices support this activity to achieve these and other actions that have stemmed from the Secretary's August 8, 1999, press release regarding the environment, safety, and health concerns at Paducah. I have asked the Director of Nuclear Energy, Science and Technology and the Assistant Secretary for Environment, Safety and Health to report jointly to me the results of the comprehensive *mass flow* review by no later than June 1, 2000, with periodic reports of results in the interim (exposure assessment activities are addressed by the now expanded medical surveillance program and its schedule). To accomplish this, EH will utilize a *working group* approach that will require site specific information relevant to these goals to be assembled, validated, and reported by March 30, 2000. They have initiated contact with cognizant site personnel to coordinate data requirements, training, and site visits.

Although it may not be feasible to reconstruct a perfect mass balance for the recycled uranium produced in DOE, we expect that engineering estimates and judgment will allow us to arrive at an understanding of the flow and characteristics of the material that is sufficient to inform our health and environmental programs, characterize radiological conditions to bound occupational radiation exposures and guide the expansion of medical screening of current and former workers.

Questions on the specifics of the above tasks can be directed to Mr. Mark Williams, EH-3, at (202) 586-2407, or Ms. Betsy Connell, NE-2, at (202) 586-6441.

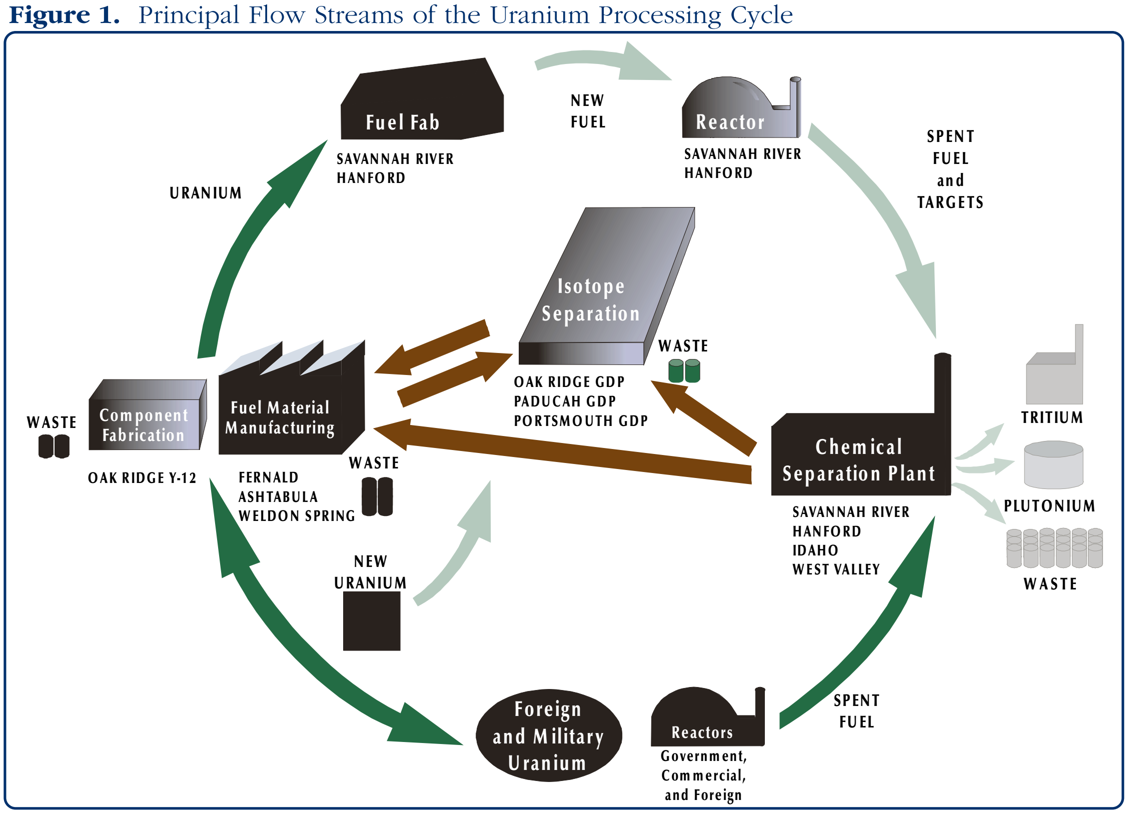
HISTORICAL GENERATION AND FLOW OF RECYCLED URANIUM IN THE DOE COMPLEX

INTRODUCTION

Uranium at DOE and its predecessor agencies was used in fission reactors to produce plutonium and tritium for weapons production. Uranium demand was high, and the resource relatively scarce, especially in the early days of production. After irradiation in the reactor, the spent fuel containing unconsumed uranium, fission products, and transuranic (TRU) elements was reprocessed in chemical separations facilities at the Hanford, Savannah River, Idaho, and West Valley sites to separate the plutonium from the remaining uranium and fission products. The uranium was also recovered, converted to a transportable form, generally UO_3, and then sent for enrichment or other processing. Enrichment occurred at the gaseous diffusion plants at Paducah, Oak Ridge, and Portsmouth. The gaseous diffusion plants converted the incoming uranium to uranium hexafluoride (UF_6) for enrichment. Conversion to metal and blending for reactor fuel or targets were conducted at Fernald, Weldon Spring, or Oak Ridge Y-12. Figure 1 illustrates the principal flow streams in the DOE uranium processing cycle.

The recycled uranium sent from the chemical separations facilities contains trace amounts of residual TRU elements (includ-

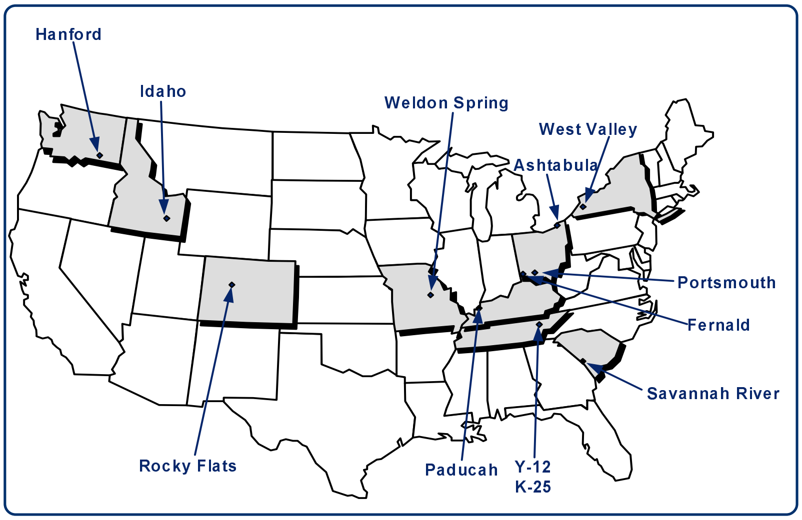
Figure 1. Principal Flow Streams of the Uranium Processing Cycle



ing neptunium (Np) and plutonium (Pu)), fission products (such as technetium (Tc)), and reactor-produced uranium isotopes (such as uranium-236 (^{236}U)). The presence of these constituents in the recycled uranium stream makes it more radioactive than natural uranium. If this recycled uranium material is depleted of its ^{235}U isotope (i.e., ^{235}U less than 0.7%), it may still contain traces of reactor-generated isotopes which cause it to be more radioactive than depleted uranium obtained from natural sources. Therefore, health and environmental concerns are increased when processing recycled uranium.

From the start of its use by DOE and its predecessor agencies – the Manhattan Project, the Atomic Energy Commission, and the Energy Research and Development Administration – over 100,000 metric tons of recycled uranium were processed. This material was sent to many locations throughout the country for various purposes. Figure 2 shows the location of major sites that processed recycled uranium. The presence of plutonium, neptunium, and fission products in the recycled uranium feed material sent to the Paducah Gaseous Diffusion Plant has caused concern among the workers and public. In August 1999, workers at Paducah raised concerns about exposure to this recycled material, including allegations of exposure to plutonium. As a result, DOE formed an investigative team to specifically respond to the workers' concerns and to address potential environmental contamination from recycled uranium. Therefore, DOE needs to have a sufficiently thorough understanding of the mass flow and characteristics of this recycled material in order to assess the potential for health or environmental contamination issues.

Figure 2. Map of Recycled Uranium Sites



ES&H MASTER PLAN

The Office of Environment, Safety and Health (EH) at DOE initiated five projects to investigate legacy issues associated with recycled uranium at DOE's gaseous diffusion and other linked plants. These five projects are: (1) the Office of Oversight (EH-2) performing an inspection at the three Gaseous Diffusion Plants (GDP) to document current and past practices; (2) the Office of Nuclear Safety (EH-3) conducting this project to review the characteristics and flow of uranium throughout the Department; (3) the Office of Worker Health and Safety (EH-5) conducting an exposure assessment project to establish worker radiation exposure profiles at the Paducah, Portsmouth, and East Tennessee Technology Park (ETTP) sites; (4) the Office of Health Studies (EH-6) expanding the medical surveillance program for gaseous diffusion plant workers and seeking support for compensation legislation; and (5) the EH Policy Integration project effectively communicating the status of these projects to key stakeholders and across the DOE organizations.

PROJECT OBJECTIVE

The overall objective of this mass balance project (Historical Generation and Flow of Recycled Uranium in the DOE Complex) is to identify where recycled uranium could have created an exposure hazard to the workers and an estimation of the numbers of workers potentially exposed. Significant contamination to the environment will also be estimated. This requires a reconstruction of the historical flow and processing of recycled uranium, a project with three fundamental elements as defined in the authorization memorandum presented at the beginning of this Project Plan:

- Identify the mass flow of recycled uranium throughout the DOE complex.
- Identify contaminants in the mass flow.
- Conduct site-specific mass balance activities sufficiently thorough to identify health, safety, and environmental concerns.

PROJECT SCOPE

This project will review irradiated, recycled uranium generated and processed by DOE

Table 1. Isotopes - Recycled Uranium

Isotope	Half-Life	Specific Activity, Ci/g	Primary Emission	Gamma Emission, MeV
Normal Uranium and Daughters				
^{230}Th	7.54×10^4y	2.06×10^{-2}	alpha, 4.8 MeV	
^{231}Th	1.63d	3.46×10^5	beta, 0.39 MeV	0.026, 0.084
^{234}Th	24.1d	2.31×10^4	beta, 0.19 MeV	0.063, 0.093
^{234}Pa	1.17 min	6.85×10^8	beta, 2.29 MeV	0.765, 1.00
^{234}U	2.45×10^5y	6.23×10^{-3}	alpha, 4.7 MeV	0.053
^{235}U	7.04×10^9y	2.16×10^{-6}	alpha, 4.5 MeV	0.144, 0.186
^{238}U	4.46×10^9y	3.36×10^{-7}	alpha, 4.2 MeV	
U and TRU Reactor Products				
^{236}U	2.34×10^7	6.47×10^{-5}	alpha, 4.9 MeV	0.112
^{237}Np	2.14×10^6	7.04×10^{-4}	alpha, 5.0 MeV	0.087
^{238}Pu	87.74y	17.1	alpha, 5.6 MeV	
^{239}Pu	2.41×10^4y	6.20×10^{-2}	alpha, 5.2 MeV	
^{240}Pu	6.58×10^3y	0.226	alpha, 5.1 MeV	
^{241}Am	432.2y	3.43	alpha, 5.6 MeV	0.0595
Fission Products Half-Life > 1y				
^{90}Sr	2.91y	136	beta, 0.55 MeV	
^{99}Tc	2.31×10^5y	1.69×10^{-2}	beta, 0.29 MeV	
^{106}Ru-Rh	1.02y	3.30×10^3	beta, 3.54 MeV	0.511, 0.62
^{125}Sb	2.76y	1.03×10^3	beta, 0.77 MeV	0.38, 0.46, 0.64
^{137}Cs	30.3y	86	beta, 1.18 MeV	0.661
^{144}Ce	284.6d	8.71	beta, 0.32 MeV	0.134
Fission Products Half-Life < 1y				
^{95}Zr-Nb	64-35d	$>10^4$	beta, 0.93 MeV	0.77
^{103}Ru	39.3d	$>10^4$	beta, 0.76 MeV	0.29, 0.44, 0.61
^{141}Ce	32.5d	$>10^4$	beta, 0.58 MeV	0.145

^{233}U is produced by irradiation of Th, and is not included in the project scope.

over the last 50 years. The facilities that processed recycled uranium were located primarily at the 12 domestic sites shown in Figure 2; however, the flow of uranium also included shipments to (or from) foreign countries (primarily England, France, and Russia), domestic commercial facilities for nuclear fuel fabrication or processing, and other affected sites.

Figure 1 illustrates the scope of this project, and was developed from other pertinent documents including *Linking Legacies*[1] and the *Report of the Joint Task Force on Uranium Recycle Materials Processing*[2].

This project will update and expand upon the information in the Joint Task Force report, characterize the remaining recycled uranium streams in DOE, and provide quantitative information on the materials in uranium recycle streams. The recycle streams will be characterized, to the extent practical, as to the content of fission products and transuranics from an environment, safety, and health perspective. The potential isotopes of interest are included in Table 1. The transuranics of plutonium and neptunium and the fission product technetium are of greatest interest. This project will also identify process locations and time periods for facilities of importance to worker exposure or environmental contamination.

The review will cover the period from the early days of production to March 31, 1999 and include, at a minimum, the sites in Table 2. The review will also consider foreign sources of recycled uranium.

Most of the uranium processed in the DOE complex contained little, if any, TRU or fission product isotopes. To ensure that project resources were applied to the recycled uranium flows that were demonstrably more hazardous than uranium itself, a process (as shown in Figure 3) was developed that will allow elimination of uranium flows that presented no significantly increased hazard. This process utilizes the evaluation procedure contained in Appendix A, "Prioritization of Uranium Flows."

PRINCIPAL FORMS OF URANIUM

Uranium metal - billets, derbies, buttons, scrap

Uranium oxides - orange oxide (UO_3), black oxide (UO_2), green oxide (U_3O_8), uranium in solutions, uranyl nitrate [UNH]

Uranium fluorides - green salt (UF_4), gaseous (UF_6)

Uranium waste - off-specification material in any of above forms or waste containing significant amounts of uranium that would affect mass balance activities

All DOE reactor-irradiated and recycled uranium is within the scope of this project. This includes natural, depleted, and enriched uranium. Recycled uranium flowing through the DOE complex could exist in many forms such as metals, oxides, and fluorides. Although most of the transuranic and fission-product materials were removed in the chemical separation processes such as REDOX and PUREX, trace concentrations of these substances remained with the uranium after chemical separation.

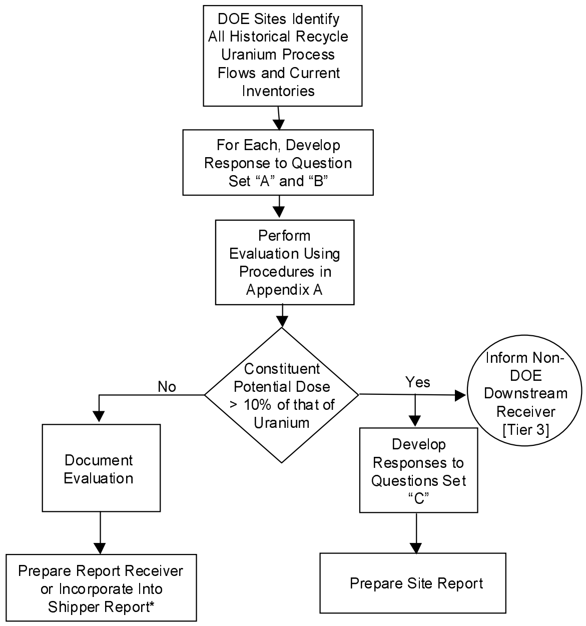
Table 2. Sites Covered by This Review

Tier 1 Sites	Tier 2 Sites	Tier 3 Sites
DOE source sites for recycled uranium	DOE enrichment and manufacturing sites	Other affected DOE sites
Hanford Savannah River Idaho West Valley	Oak Ridge K-25 Paducah Portsmouth Fernald Weldon Spring Oak Ridge Y-12 Ashtabula Rocky Flats	Argonne East Argonne West Los Alamos National Laboratory Lawrence Livermore National Laboratory Mound Pantex Sandia National Laboratory Brookhaven National Laboratory Ames Laboratory

[1]*Linking Legacies,* DOE Office of Environmental Management (DOE/EM-0319), January 1997.

[2]*Report of the Joint Task Force on Uranium Recycle Materials Processing,* DOE Oak Ridge (DOE/OR-859), September 1985.

Figure 3. Flow Chart of Actions Involved in Preparing Recycled Uranium Project



* A short report format is presented in this Appendix for sites whose uranium streams qualify for exclusion

PROJECT ORGANIZATION

The Deputy Secretary of Energy, as the Chief Operating Officer of DOE, authorized and directed the initiation of this review on September 15, 1999. Lead Program Secretarial Officers are responsible for conducting their portions of the review with the support of the operations office managers. The Assistant Secretary for Environment, Safety and Health is the lead organization to coordinate the review and prepare the overall report.

This project crosscuts the entire Department, and requires extensive cooperation among multiple DOE Headquarters program and operations offices, site contractors, national laboratories, and external stakeholder representatives. It requires significant senior management attention, commitment from responsible DOE and site contractor organizations, and openness to information sharing. Teams have been designated with specific responsibilities to facilitate the review process. This review will require the marshalling of technical expertise to develop information that will be useful to decision-makers. At specific stages in the project, team leaders and management representatives may brief Program Office directors and other senior Departmental staff to minimize surprises and to facilitate the timely completion of this project.

WORKING GROUP PROCESS

This review will use a "working group" concept, with key representatives from participating offices assigned responsibility for a designated site and membership. Field Offices will designate lead federal and contractor representatives to participate on a Site Team for this review. An active peer review process will be utilized between a Headquarters Team, Site Teams, and Working Group Teams to ensure the quality of the information generated by this project. This review will be accomplished by a working group process that includes:

- Site-specific reviews and reports by the Site Teams.
- Site visits by a Working Group Team to assess the site report and resolve intersite discrepancies.
- Coordination across sites and sharing of results.
- Central, organizationally-integrated analysis by the Headquarters Team and its Data Analysis Subteam.
- Preparation of a complex-wide report by the Headquarters Team, with assistance from the Working Group Teams.
- Site and Program Office reviews of the complex-wide report.
- Stakeholder involvement.

The Project Participant List, included near the end of this plan, provides names of the members of the Headquarters Team, Working Group Team leaders, and Site Team leaders.

Site Teams

These site teams are composed of operating contractor personnel. DOE site personnel may also participate on these teams. These teams will obtain and summarize site-specific recycled uranium data over the site's history, including mass flow, constituent data, mass balance, and current inventory as of March 31, 1999. Processes, locations, and time periods of importance to worker exposure and the probable number of workers exposed. Environmental contamination issues will be identified. The Site Team will also prepare the site report and work with the Working Group Team and Headquarters Team to resolve data conflicts and validate data.

Working Group Teams

These teams consist primarily of DOE Headquarters federal staff. DOE contractors or DOE site staff members from sites other than those being visited may be members of a Working Group Team. They will validate site data and reports, assist in resolving cross-site data conflicts, and contribute to the final site report as necessary. Working Group Team members, and the schedule for site visits, are presented in Table 3.

Headquarters Team

This team consists primarily of DOE Headquarters federal staff. It provides project direction and technical guidance and will compile the complex-wide report with assistance from the team leaders of the working groups. The Headquarters Team

Table 3. Preliminary Working Group Team Site Visit Schedule

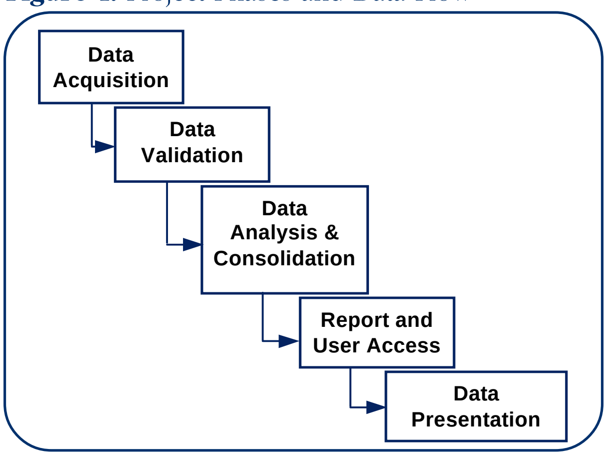
Site/Working Group Team (Site Visit Date)	Team Leader	Mass Flow	Processes	Health Physicists	Administrative Support
Portsmouth (TBD)	L. Crossman HQ	C. Clark Hanford	G. Connor Oak Ridge Ops	R. Bauman Weldon Spring	Site will supply
Oak Ridge K-25 (TBD)	R. Felt HQ	C. Raeder HQ	B. Sheward Porstmouth	J. Barker Y-12	
Idaho Chemical Processing Plant (TBD)	D. Blaney HQ	D. Chumbler Paducah	R. Borisch Hanford	B. Rich Parallax	T. Fritz-Powers
Paducah (TBD)	R. Felt HQ	G. Clark Hanford	J. Carter Oak Ridge Ops.	R. Bauman Weldon Spring	
Savannah River (TBD	T. Tracy HQ	D. Chumbler Paducah	J. Styne West Valley R. Lopiccolo HQ	J. Barker Y-12	Site will supply
Hanford (TBD)	L. Crossman HQ	P. Dessaules SAIC	D. Harlow HQ	B. Rich Parallax	
Fernald, Ashtabula, Weldon Spring, West Valley (TBD)	D. Harlow HQ R. Garber Parallax	L. McCarty SRS J. Craig	M. Peterson Weldon Spring	R. Bauman Weldon Spring	
Oak Ridge Y-12 Oak Ridge X-10 (TBD)	R. Felt HQ	D. Lee Ohio	T. Clark Fernald	J. Baker Y-12	
Rocky Flats (TBD)	E. Branagan HQ	T. Williams SRS	L. Lundberg Y-12		M. Allen
Minor/Foreign Sites (TBD)	B.K. Singh HQ	P. Dessaules SAIC			

members are listed in the Project Participant List. A subteam of the Headquarters Team, the Data Analysis Subteam, will assist with analysis and consolidation of site report data for the final complex-wide report.

DATA GENERATION PROCESS

Figure 4 identifies the five phases to completion of this project. Each of the five phases of this project, along with the specific data generation steps, are discussed in detail below.

Figure 4. Project Phases and Data Flow



Data Acquisition

Each major DOE site will assemble an interdisciplinary Site Team to conduct a review of the flow of recycled uranium, constituent concentrations, and mass balance. The Site Team will use the site report outline (Appendix B) to guide the site reviews. Completion of the site reports in the detail required in Appendix B will ensure that the more fundamental questions that need to be addressed on a complex-wide basis (Table 4) may be answered in a comprehensive manner. Special emphasis must be given to the following:

- Describing the amounts, characteristics, and constituents of the incoming and outgoing product streams.
- Understanding of the historical processes, product specifications, and process activities that concentrated radionuclides.
- Determining the facilities and processes that could cause worker exposures or lead to measurable environmental contamination.

To ensure that proper emphasis is afforded to the uranium flows that most warrant attention, a team of DOE personnel considered the hazard of the constituents in recycled uranium relative to the hazard of uranium itself. The team determined that the concentration of constituents that caused an additional dose equal to or less than 10% caused by the dose of uranium. A procedure that considers chemical form and constituent radiological concentrations was developed (see Appendix A) to enable sites to exclude flows that have a hazard that is not significantly more hazardous than the uranium. This procedure may be used to exclude selected flows from the review if site data are sufficient to support constituent data.

Site data may be obtained from sources including the following:

Historical Site-Specific Reports — These reports are summary source documents that were generated in real time, usually for the specific purpose of tracking material or dealing with some aspect of its processing or use. They usually summarized transactions on a quarterly or annual basis and were produced by or for organizations controlling or monitoring the flow of nuclear materials.

Site Process Data — Evaluation of on-site processes is of vital importance in understanding worker exposure. Process documents should be reviewed for potential streams that could concentrate the contaminants. Site-specific databases may have been established to accommodate the tracking of specific shipment requests and in-process contaminants.

Table 4. Question Set for Historical Generation and Flow of Recycled Uranium in the DOE Complex

Question Set

The purpose of this question set is to provide a common approach to the identification of facilities, processes and time frames of measurable worker exposures or environmental releases of TRU or fission product isotopes from recycled uranium. This question set also addresses the characterization of the flow of recycled material within DOE and the conduct of the mass balances for sites in this review. Each site team will prepare a site report (per the Site Report Outline in Appendix B). The following question set should be considered in constructing the site report.

Questions

A. Determine the annual mass flow of recycled uranium throughout the DOE system from the start of processing to mid-FY 1999, including ultimate use and disposition

1. What is the annual quantity of recycled uranium (RU) shipped by the site to each receiving site by material type?
2. What are the annual receipts of RU by shipping site and material type?
3. What are the annual quantities of material that were derived from both RU product as well as other recycled material sent to other sites or for ultimate use?
4. What is the annual quantity of RU-derived waste, material unaccounted for, or other categories?
5. What is the inventory of RU-derived material stored or in process as of March 31, 1999?

B. Identify the characteristics and contaminants in the major uranium streams; specifically, technetium, neptunium, and plutonium or other isotopes of concern to worker or public health and safety.

1. What are the characteristics and constituent levels for the principal RU streams?

   The characteristics of the stream include the chemical form, the uranium isotopic composition, and the constituent levels, including ^{239}Pu, ^{237}Np, and ^{99}Tc. Constituent concentrations should be expressed as normal annual average levels, and significant upsets outside of the normal range should be noted where available.

2. What are the intra-site transfers that could involve personnel exposure to RU contaminants?
3. What are the processes that could concentrate trace contaminants, and what is the probable concentration factor by isotope or groups of isotopes?
4. What are the process and product specifications for allowed constituent concentrations and the time periods over which the specifications were in effect?
5. What activities or facilities, over what time period, could have led to significant worker exposure or environmental contamination?

C. Conduct Site Mass Balance Activities Sufficiently Thorough to Identify Significant Implications or Worker Exposure or Environmental Contamination

1. What is the fraction of the annual quantity of irradiated recycled uranium shipped from the site or moved within the site for processing that contains levels of constituent (Pu, Np, other TRU and/or fission products) that could have significant implications for personnel exposure or environmental contamination?
2. What is the typical and maximum annual concentrations of constituents (Pu, Np, other TRU and/or fission products) in the uranium reported in C.1.?
3. What are the significant processes or material streams in each facility handling recycled uranium?
4. Where did the transuranics or fission products go? Were they concentrated in waste? Were they released to the environment? What does the mass balance show?
5. What are the processes and material handling procedures that could result in exposures to personnel or the public to RU or, more importantly, its associated contaminants?

Transaction Reports/Data — These reports or data track the flow of nuclear material into, out of, and within the site so as to reduce or eliminate the possibility of theft or diversion.

DOE Historical Reports — Historical reports consist of various reports that contain summary or rolled up data, but are not material source documents. They may have been produced years after material transactions took place, and have varying degrees of accuracy.

Nuclear Materials Management and Safeguards System (NMMSS) Data — The NMMSS system is DOE's and NRC's official database to account for fissile materials. NMMSS can be used as a resource to characterize the total amounts of depleted, enriched, and natural uranium for each site on an annual basis. Data are generally available for time periods after 1969. Sites should contact the DOE Office of Plutonium, Uranium, and Special Materials Inventory to obtain NMMSS data.

Site Report — Each Site Team will prepare a site report following the report outline in Appendix B, which provides the report format for the written report, including forms for collecting the data. The report will detail the annual amounts of recycled uranium received and shipped, constituent concentrations (average and range), processes, locations, and time periods associated with the potential for significant worker exposures or environmental releases, and a mass balance. The number of workers having significant exposures will also be estimated.

The site will attempt to compare its data with data from sites that shipped or received uranium to or from the site and resolve any discrepancies. Data discrepancies that are not resolved will be identified and turned over to the Working Group Team to assist with resolution. Documentation and supporting information must be sufficient to allow verification of the report and help to resolve differences between sites.

Data Validation

The Working Group Team assigned to the site will visit the site and review and assess the draft site report. A report assessment checklist is presented in Appendix C to facilitate the review. Part of the review will be to compare the report with the site's supporting information and data from sites that shipped to or received uranium from the site. This review and assessment will serve as data validation. The Working Group Team will also attempt to resolve data discrepancies between sites and will document the resolution. Upon completion of the review, the Working Group Team will provide comments and corrections to the Site Team for consideration and inclusion into the site report. A hard copy and an electronic version of the site report will be prepared – the electronic version will be used to directly populate the uranium mass balance database that has been established at DOE Headquarters. It will also permit direct inclusion of site information into the complex-wide report.

Prior to a site visit, the Working Group Team should review the spreadsheet and other information supplied by the site, and be familiar with the overall uranium flow charts. The team leader will interact with the site representative to arrange the visit.

The visit should accomplish the following:

- Conduct an entrance and exit meeting to establish and summarize goals and accomplishments.
- Conduct daily meetings with site and facility personnel to become knowledgeable of site information.

- Review data sources to understand their completeness and validity.
- Ensure that both the team and site staff agree on the level of quality for the information, and characterize the confidence level in the information. Ensure that all practical steps are taken to obtain complete information.
- Prepare a plan to resolve incomplete or inconsistent information, agreed to by both the team and site representatives.
- Provide mass balance information to the home team.
- Assist the site with cross-site inquiries to resolve discrepancies.
- Prepare assessment of site report (Appendix C - Assessment Plan).

Data Analysis

The Headquarters Team will review the site report and analyze the site data for consolidation into the DOE complex-wide report. The Site Teams and Working Group Teams will assist in this effort. Substantive comments on the site report resulting from the review and data analysis will be transmitted to the Site Team for incorporation into the final site report before publication.

The Site Teams will work with the Working Group Teams to resolve and document intersite recycled uranium transaction mass balance and constituent concentration discrepancies.

The HQ Team through its Data Analysis Review Subteam will:

- Review and compile all detailed and summary data provided from each site.
- Identify imbalances in the transactions and verify that anomalies reported from the field sites have been resolved.
- Document all resolutions to intersite data discrepancies. In those cases where there is insufficient information to justify a resolution, the team will document the anomaly and keep track of the unresolved errors.
- Support the declassification of data targeted for DOE stakeholders to ensure public reports do not represent a classification issue due to the comprehensive nature of the source data.

Data Consolidation and Presentation

The Data Analysis Review Subteam will produce the minimum requirements for the introduction of site data into the mass balance database. These requirements identify the report format and minimum set of data required from the sites. The uranium mass balance database will provide DOE management with an authoritative record of the mass balance of recycled uranium with constituent concentrations within the Department.

Report Generation and User Access

The DOE complex-wide report will provide an estimate of the mass and flow of uranium with the concentrations of constituents (e.g., Pu isotopes, ^{237}Np, ^{99}Tc) throughout the DOE complex. In addition, processes, locations, and time periods of importance to worker exposure or environmental contamination will be presented.

Summary data released to the public will be reported through a separate public uranium mass balance database. This database will be unclassified. If possible, the data released for public use will be formatted so that each individual site can be reviewed, detailing the amounts of material received and shipped on an annual basis, and the amount of constituents present.

CLASSIFIED INFORMATION

Some information about materials and processes necessary to this project may be classified, however, it is the goal of this project to present and report as much information as possible in an unclassified form. General summaries will be compiled in an unclassified form.

Appropriate DOE security requirements will apply to all activities in this review. Personnel must properly separate and identify unclassified and classified information about their site. Classified information should be considered for declassification. If the information cannot be declassified, it will be placed in classified appendices or attachments to reports. If necessary, arrangements to transfer the classified material to a DOE Headquarters classified area will be made, however, it is preferred that classified information be available and retained at the respective sites.

STAKEHOLDER INVOLVEMENT

A high level of external stakeholder involvement for this project is not anticipated. However, stakeholder interest may arise, especially at the gaseous diffusion sites. Operations Offices are responsible for initiating and coordinating involvement by local internal and external stakeholders. At a minimum, the following types of stakeholders should be addressed:

Internal

- Site DOE and contractor senior management should be briefed on the project, its goals, and general aspects of the project plan. Issues may arise in these briefings that warrant DOE management resolution. The Working Group Team or Headquarters Team should be consulted as needed.
- Briefings should be conducted to inform workers and management involved in this project of the goal of the study and the associated question sets.

External

Consideration should be given to coordination with stakeholders at the major sites upon completion of the site reports. The following types of stakeholders may wish to participate:

- State and federal regulatory agencies
- Tribal nations representatives
- Citizens and public interest organizations including the families of historic and present workers
- Union representatives
- Local officials such as the mayor and city council
- Media representatives
- Citizen advisory boards

The Operations Offices are responsible for defining any involvement by these or other citizen/worker interest groups or news media.

The Operations Offices should be responsible for notification, inquiries, and other communications and logistical arrangements. To ensure consistent and accurate information and to provide for classification review, all communications should be made through a single point of contact designated by the Operations Office.

The Operations Offices should also coordinate their efforts with the DOE Headquarters Office of Public Affairs.

Some generic stakeholder and press inquiries about this project have been directed to the DOE Headquarters Office of Public Affairs. As the project nears completion, briefings with stakeholders may be held at each site. Technical information about the assessment that is needed for any communication with stakeholders should be provided by the designated point of contact, working in coordination with the local public affairs staff.

SCHEDULE

The Deputy Secretary, in his memorandum dated September 15, 1999, directed the following:

- Site reports are to be assembled, validated, and reported by March 30, 2000.
- The comprehensive mass flow review must be completed by June 1, 2000.

DELIVERABLES

The deliverables for this project consist of a series of site-specific reports addressing the goals, a final complex-wide report, and associated project database. Deliverables will be stand-alone documents. The final report will be unclassified, and the associated database will also be unclassified. Individual site reports will be summarized and referenced in the consolidated final report.

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GLOSSARY

Chemical Separation

A process for extracting uranium and plutonium from dissolved spent nuclear fuel and irradiated targets. The fission products that are left behind are high-level waste. Chemical separation is also known as reprocessing.

Decay (Radioactive)

Spontaneous disintegration of the nucleus of an unstable atom that results in the emission of particles and energy.

Decay Product

An isotope that results from the decay of an unstable atom.

Decontamination

Removal of radioactive or hazardous material through a chemical or mechanical process.

Department of Energy (DOE)

The Cabinet-level U.S. Government agency responsible for nuclear weapons production, energy research, and the cleanup of hazardous and radioactive waste at its sites. It was created from the Energy Research and Development Administration and other federal government functions in 1977.

Disposition

Reuse, recycling, sale, transfer, storage, or disposal of materials.

Fissile

Capable of being split by a low-energy neutron. The most common fissile isotopes are ^{235}U and ^{239}Pu.

Fission

The splitting of a nucleus of a heavy atom such as plutonium or uranium, usually caused by absorption of a neutron. Large amounts of energy and one or more neutrons are released when an atom fissions.

Fission Products

The large variety of smaller atoms left over from fission of uranium or plutonium. Most of these atoms are radioactive, and decay into other isotopes. There are more than 200 isotopes of 35 elements in this category. Most of the fission products in the U.S.are in spent nuclear fuel and high-level waste.

Fuel (Nuclear)

Natural or enriched uranium that sustains the fission chain reaction in a nuclear reactor. Also refers to the entire fuel element, including structural materials such as cladding.

Fusion

The process whereby the nuclei of lighter elements, especially the isotopes of hydrogen (deuterium and tritium), combine to form the nucleus of another element, accompanied by the release of substantial amounts of energy.

Irradiate

The exposure to ionizing radiation, usually in a nuclear reactor. Targets are irradiated to produce isotopes.

Isotopes

Different forms of the same chemical element that differ only by the number of neutrons in their nucleus. Most elements have more than one naturally occurring isotope produced in nuclear reactors and scientific laboratories.

Nuclear Reactor

A device that sustains controlled nuclear fission chain reactions.

Plutonium

A man-made fissile element. Pure plutonium is a silvery metal that is heavier than lead. Material rich in the ^{239}Pu isotope is preferred for manufacturing nuclear weapons, although almost any plutonium can be used.

Production Reactor

A nuclear reactor that is designed to produce man-made isotopes. Tritium and plutonium are made in production reactors. The United State has 14 such reactors: nine at the Hanford Site and five at the Savannah River Site. Some research reactors are used to produce isotopes.

Radiation

Energy transferred through space or other media in the form of particles or waves.

Radioactivity

The spontaneous emission of radiation from the nucleus of an atom. Radionuclides lose particles and energy through this process of radioactive decay.

Radioassay

The qualitative or quantitative analysis of a radioactive substance often used to determine the proportion of isotopes in radioactive materials.

Radionuclide

A radioactive species of an atom. Tritium (^{3}H) and ^{235}U are examples of radionuclides.

Recycled Uranium

Uranium that is recovered from spent reactor fuel or irradiated targets using chemical separation processes including REDOX and PUREX.

Reprocessing

Synonymous with chemical separation.

Stakeholder

Anyone interested in, or affected by, Department of Energy activities.

Target

Material placed in a nuclear reactor to be bombarded with neutrons. When this is done, it produces new man-made radioactive materials. Targets of ^{235}U are used to make plutonium, and targets of lithium are used to make tritium.

Transuranic Elements

All elements beyond uranium on the periodic table. All of the transuranic elements are man-made.

Tritium

The heaviest isotope of the element hydrogen. Tritium boosts the explosive power of most modern nuclear weapons. It is produced in production reactors, and has a half-life of over 12 years.

Uranium

The basic material for nuclear technology. It is a slightly radioactive, naturally occurring heavy metal that is more dense than lead, and 40 times more common than silver. The most common isotopes are ^{235}U and ^{238}U.

Uranium Enrichment

The process of separating isotopes of uranium from each other.